C1 hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and a denominator is an integer greater than 1].

Claim 54, line 1, replace "maintains" with -- is constructed and arranged to be capable of maintaining --.

C2

4 ~~55~~. (Amended) A cell according to claim ~~52~~ 1, [whereby said gaseous hydrogen atoms are formed in the cell by reacting] further comprising a source of hydrogen atoms including molecules containing hydrogen atoms, and a second catalyst for disassociating said molecules to produce hydrogen atoms.

C3

~~56~~ 5. (Amended) A cell according to claim ~~55~~ 4, wherein said second catalyst [is] comprises at least one element selected from the group consisting of transition elements, [and] inner transition elements, precious metals, refractory metals, lanthanides, actinides, and activated charcoal.

~~59~~ 8. (Amended) A cell according to claim ~~52~~ 1, wherein said gaseous catalyst is formed from a source of gaseous catalyst which is adapted to sublime, boil, or volatize when heated.

C4

~~69~~ 18. (Amended) A cell according to claim ~~52~~ 1, [whereby] wherein said vessel includes temperature controlling structure capable of maintaining [maintains a] an atomic hydrogen partial pressure of less than about 1 torr.

C5

~~70~~ 19. (Amended) A cell according to claim ~~52~~ 1, wherein said vessel includes temperature controlling structure capable of maintaining [maintains] said catalyst in molten form.

121

71. (Amended) A cell according to claim 52, wherein said vessel includes temperature controlling structure capable of maintaining the temperature of said vessel [is maintained] at about 50°C above the melting point of said gaseous catalyst.

72. (Amended) A cell according to claim 52, wherein said vessel is constructed and arranged to be capable of maintaining the hydrogen partial pressure in said vessel [is maintained] at about 200 millitorr.

73. (Amended) A cell according to claim 66, wherein said vessel includes temperature controlling structure capable of maintaining the temperature of said vessel [is maintained] at about 50°C above the [higher] melting point of [compounds of] the compound having the highest melting point of a plurality of compounds which comprise a source [two cations comprising said cation pair] of said gaseous catalyst.

Claim 74, line 1, delete "selectively".

Claim 75, line 1, delete "selectively".

76. (Amended) A cell according to claim 52, wherein said vessel includes temperature controlling structure to control a temperature of said vessel [the vapor pressure of said gaseous catalyst varies with temperature].

78. (Amended) A cell according to claim 52, further comprising a catalyst reservoir communicating with said reaction vessel, said catalyst reservoir containing said gaseous catalyst or a source [thereof] of gaseous catalyst.

Claim 84, line 1, replace "832" with - - 82 - -.

122

~~85.~~ 134 (Amended) A cell according to claim ~~82~~ 31, wherein said source of hydrogen atoms comprises a tungsten capillary constructed and arranged to be heated [to between 1800 and 2000K] for dissociating molecules containing hydrogen atoms to produce said gaseous hydrogen atoms.

C8

Claim 91, line 2, replace "energy" with - - power - -.

~~92.~~ 145 (Amended) A method for extracting energy from hydrogen atoms comprising the steps of:

providing a gaseous catalyst having a net enthalpy of reaction of about 27 * (p/2) eV, where p is an integer greater than 1;

providing gaseous hydrogen atoms; and

reacting said gaseous catalyst with said gaseous hydrogen atoms, thereby releasing energy from said gaseous hydrogen atoms [producing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and a denominator is an integer greater than 1,

said reaction occurring at a pressure less than atmospheric pressure].

C9

Claim 94, line 2, replace "catalyst" with - - second catalyst - -.

Claim 107, second line, delete "said".

Please add new claims 108-551 as follows.

- ~~108.~~ 141 A cell according to claim ~~52~~ 1, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction and which is adapted to sublime, boil or become volatile when heated.

C10

123

42 109. A cell according to claim 52, wherein said source of gaseous catalyst comprises an ionic compound which is adapted to sublime, boil or become volatile when heated.

43 110. A cell according to claim 52, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to thermal degradation.

44 111. A cell according to claim 52, wherein said gaseous catalyst is formed from at least one metal selected from the group consisting of Mo, Ti, and Rb.

45 112. A cell according to claim 52, wherein said gaseous catalyst is formed from at least one salt selected from the group consisting of MoI_2, $TiCl_2$, $TiCl_4$, $SnCl_4$, $SiCl_4$, $PrBr_3$, $CaBr_2$, $SrCl_2$, CrI_2, TbI_3, $SbCl_3$, CrF_3, $CoCl_2$, $BiCl_3$, $NiCl_2$, PdF_2, InCl, $LaCl_3$, $DyCl_3$, LaI_3, HoI_3, KNO_3, VF_3, PbF_2, VOCl, PbI_2, $LuCl_3$, $PbCl_2$, AsI_3, HoI_3, $MoCl_5$, $SnCl_4$, SbI_3, CdI_2, AgF_2, AgF, LaI_3, ErI_3, VCl_4, BCl_3, $FeCl_3$, $TiCl_3$, CoI_2, CoF_2, TlI, TlF, $BiBr_3$, $ZnBr_2$, AsI_3, DyI_3, $HoCl_3$, $MgCl_2$, $CrCl_3$, $PrCl_3$, $SrCl_2$, $FeCl_2$, $NiCl_2$, CuCl, $SrCl_2$, $MoCl_2$, YCl_3, $ZrCl_4$, CdI_2, BaI_2, HoI_3, PbI_2, PdF_2, LiF, $EuCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $BiCl_4$, $AlCl_3$, $CaBr_2$, $SmBr_3$, VaF_3, $LaCl_3$, GdI_3, CrI_2, MnI_2, $YbBr_3$, $FeBr_2$, $NiCl_2$, AgCl, $ZnCl_2$, $YbCl_2$, SeF_4, $SnCl_4$, SnF_4, SbI_3, BiI_2, EuF_3, and $PbCl_2$.

C10

46 113. A cell according to claim 52, wherein said catalyst comprises potassium and has a net enthalpy of reaction of 27.28 eV.

47 114. A cell according to claim 52, wherein said catalyst has a net enthalpy of reaction of about 27.2 eV.

48 115. A cell according to claim 52, wherein said cell comprises a source of said gaseous catalyst combined with at least one of a hydrocarbon or water disposed such that said gaseous catalyst and said gaseous hydrogen atoms are capable being formed during combustion.

134

49 1
116. A cell according to claim 52, further comprising a means for converting a source of catalyst to said gaseous catalyst.

50 49
117. A cell according to claim 116, wherein said means for converting said source of catalyst to said gaseous catalyst comprises at least one of heat, electron-beam energy, photon energy, acoustic energy, electric field, or magnetic field.

51 1
118. A cell according to claim 52, further comprising a filament coated with a source of gaseous catalyst.

52 1
119. A cell according to claim 52, further comprising a source of gaseous hydrogen atoms is selected from the group consisting of hydrogen gas, water, hydrides, metal-hydrogen solutions, and hydrocarbons.

C10

53 52
120. A cell according to claim 119, further comprising means to disassociate water to form gaseous hydrogen atoms.

54 1
121. A cell according to claim 52, further comprising a hot filament and a hydrogen containing gas stream.

55 1
122. A cell according to claim 52, further comprising a hot grid and a hydrogen containing gas stream.

56 1
123. A cell according to claim 52, further comprising a heated tungsten capillary and a hydrogen containing gas stream.

57 1
124. A cell according to claim 52, further comprising a hydride maintained under nonequilibrium conditions.

125

58 1
126. A cell according to claim 52, further comprising an inductively coupled plasma flow tube and a hydrogen gas containing stream.

59 1
126. A cell according to claim 52, further comprising means to reform hydrocarbons to at least one of gaseous molecular and gaseous atomic hydrogen.

60 4
127. A cell according to claim 55, wherein said second catalyst is treated with an aqueous solution of K_2CO_3 and H_2O_2.

61 4
128. A cell according to claim 55, further comprising a temperature controlling structure capable of maintaining a selected atomic hydrogen partial pressure by controlling the temperature of said second catalyst.

C10

62 61
129. A cell according to claim 128, wherein said temperature controlling structure is at least one selected from the group consisting of an internal heater, an external heater, the catalysis of hydrogen, and a heat exchanger which removes energy from the cell.

63 1
130. A cell according to claim 52, further comprising a source of UV light for disassociating hydrogen containing molecules to form said gaseous hydrogen atoms.

64 1
131. A cell according to claim 52, further comprising a means for pyrolysis of hydrocarbons or water to form said gaseous hydrogen atoms.

65 4
132. A cell according to claim 55, wherein said second catalyst comprises at least one selected from the group consisting of an element, compound, alloy or mixture of transition elements, inner transition elements, iron, platinum, palladium, zirconium,

126

vanadium, nickel, titanium, Sc, Cr, Mn, Co, Cu, Zn, Y, Nb, Mo, Tc, Ru, Rh, Ag, Cd, La, Hf, Ta, W, Re, Os, Ir, Au, Hg, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Vb, Lu, Th, Pa, U, activated charcoal, and intercalated Cs carbon.

66 4
133. A cell according to claim 55, further comprising a heater to heat said second catalyst.

67 4
134. A cell according to claim 55, further comprising a filament or grid constructed and arranged to dissociate hydrogen and to heat said second catalyst.

68 4
135. A cell according to claim 55, further comprising means for controlling the power output of said cell.

69 68
136. A cell according to claim 135, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said second catalyst.

70 69
137. A cell according to claim 136, wherein said means for controlling the temperature of said second catalyst comprises a filament or grid.

71 31
138. A cell according to claim 82, further comprising a flow control means for controlling the flow of a source of gaseous hydrogen atoms or said gaseous hydrogen atoms from said chamber to said reaction vessel.

72 1
139. A cell according to claim 52, further comprising a flow control means for controlling the flow of hydrogen from said reaction vessel.

73 71
140. A cell according to claim 138, wherein said flow control means comprises a valve.

137

141. A cell according to claim 52, further comprising a vacuum pump constructed and arranged for controlling the flow of hydrogen from said reaction vessel.

142. A cell according to claim 78, further comprising a flow control means for controlling the flow of catalyst from said catalyst reservoir to said reaction vessel.

143. A cell according claim 52, further comprising means for controlling the flow of said gaseous catalyst from said reaction vessel.

144. A cell according to claim 143, wherein said means for controlling the flow of said gaseous catalyst from said reaction vessel comprises a valve.

145. A cell according to claim 52, further comprising a vacuum pump constructed and arranged for controlling the flow of said gaseous catalyst from said reaction vessel.

146. A cell according to claim 52, further comprising a nonreactive gas.

147. A cell according to claim 52, further comprising a means for controlling the amount of a nonreactive gas in said reaction vessel.

148. A cell according to claim 52, further comprising flow control means for controlling the flow of a nonreactive gas into said reaction vessel.

149. A cell according to claim 148, wherein said means for controlling the amount of nonreactive gas in said vessel comprises a valve constructed and arranged to regulate the flow of said nonreactive gas into said reaction vessel.

150. A cell according to claim 52, further comprising at least one of a valve or pump constructed and arranged for controlling the flow of a nonreactive gas from said reaction vessel.

151. A cell according to claim 52, further comprising a pump in communication with said reaction vessel.

152. A cell according to claim 52, further comprising structure for controlling the vapor pressure of said catalyst.

153. A cell according to claim 152, wherein said structure for controlling the vapor pressure of said catalyst comprises a heater constructed and arranged to control the temperature of said reaction vessel.

154. A cell according to claim 52, further comprising structure for maintaining a selected vapor pressure of said gaseous catalyst or source of said gaseous catalyst.

155. A cell according to claim 76, further comprising structure for maintaining a selected vapor pressure of said gaseous catalyst or source of gaseous catalyst.

156. A cell according to claim 155, wherein said structure for maintaining a selected vapor pressure of said gaseous catalyst or source of gaseous catalyst comprises a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir and a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

157. A cell according to claim 155, wherein said structure for maintaining a selected vapor pressure of said source of gaseous catalyst or said gaseous catalyst

comprises a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

91
158. A cell according to claim 52, further comprising a valve for releasing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1 or a compound containing said hydrogen atoms from said reaction vessel.

92
159. A cell according to claim 52, further comprising means for adsorbing energy released from said hydrogen atom.

93
160. A cell according to claim 52, wherein said vessel comprises an internal combustion chamber.

C10

94
161. A cell according to claim 93, wherein said internal combustion chamber is an engine cylinder.

95
162. A cell according to claim 52, further comprising means for controlling the power output of said cell.

96
163. A cell according to claim 95, wherein said means for controlling the power output of said cell comprises means for controlling the amount of said gaseous catalyst.

97
164. A cell according to claim 96, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the temperature of said vessel and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said reaction vessel.

130

98 95

165. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the flow of a source of gaseous catalyst or gaseous catalyst from said reaction vessel.

99 95

166. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a source of catalyst.

100 95

167. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the amount of said gaseous hydrogen atoms or a source of gaseous hydrogen atoms in said vessel.

C10 101 95

168. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the flow of gaseous hydrogen atoms or source of said hydrogen atoms into said reaction vessel.

102 95

169. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the flow of gaseous hydrogen atoms or source of said hydrogen atoms from said reaction vessel.

103 95

170. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises controlling the amount of said nonreactive gas present in said reaction vessel.

104 103

171. A cell according to claim 170, wherein said means for controlling the amount of nonreactive gas comprises means for controlling the flow of said nonreactive gas into said reaction vessel.

131

105 103
172. A cell according to claim 170, wherein said means for controlling the amount of nonreactive gas comprises means for controlling the flow of said nonreactive gas from said reaction vessel.

106 95
173. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the flow of a hydrogen containing gas over at least one of a hot filament, a tungsten capillary heated by electron bombardment, or an inductively coupled plasma flow.

107 95
174. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the power dissipated in an inductively coupled plasma flow tube.

C10

108 95
175. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the power dissipated in a hot filament, grid, or tungsten capillary heated by electron bombardment.

109 95
176. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a hot filament, grid or tungsten capillary heated by electron bombardment over which a hydrogen containing gas flows.

110 95
177. A cell according to claim 162, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a hydride maintained under nonequilibrium conditions.

111 27
178. A cell according to claim 78, further comprising means for controlling the power output of said cell.

132

112 111
179. A cell according to claim 178, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said catalyst reservoir and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said catalyst reservoir.

113 111
180. A cell according to claim 178, wherein said means for controlling the power output of said cell comprises means for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir into said reaction vessel.

114 1
181. A cell according to claim 52, further comprising a boat contained within said reaction chamber, said boat containing a source of gaseous catalyst or said gaseous catalyst.

C10

115 114
182. A cell according to claim 181, further comprising a means for controlling the power of said cell.

116 114
183. A cell according to claim 181, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said boat and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said boat.

117 27
184. A cell according to claim 78, further comprising means for measuring the temperature of said catalyst reservoir.

118 114
185. A cell according to claim 181, further comprising means for measuring the temperature of said boat.

133

119 27
~~186~~. A cell according to claim ~~78~~, further comprising a means for measuring the temperature of said source of said gaseous catalyst contained in said catalyst reservoir.

120 114
~~187~~. A cell according to claim ~~181~~, further comprising a means for measuring the temperature of said source of said gaseous catalyst contained in said boat.

121 1
~~188~~. A cell according to claim ~~52~~, further comprising means for measuring the temperature of said reaction vessel.

122 1
~~189~~. A cell according to claim ~~52~~, further comprising means for measuring the temperature of a source of said gaseous hydrogen atoms.

C10

123 4
~~190~~. A cell according to claim ~~55~~, further comprising means for measuring the temperature said second catalyst.

124 1
~~191~~. A cell according to claim ~~52~~, further comprising means to measure the cell temperature.

125 124
~~192~~. A cell according to claim ~~191~~, further comprising temperature controlling structure constructed and arranged to maintain a temperature in said reaction vessel greater than a temperature in said catalyst reservoir.

126 114
~~193~~. A cell according to claim ~~181~~, further comprising temperature controlling structure constructed and arranged to maintain a temperature in said reaction vessel greater than a temperature in said boat.

127 1
~~194~~. A cell according to claim ~~52~~, further comprising temperature controlling structure for maintaining a selected temperature of said reaction vessel.

134

128
195. A cell according to claim 52, further comprising a nebulizer or atomizer.

129
196. A cell according to claim 52, further comprising means to measure the pressure in said reaction vessel.

130
197. A cell according to claim 52, further comprising means to measure the hydrogen pressure in said reaction vessel.

131
198. A cell according to claim 52, further comprising means to measure the gaseous catalyst pressure in said reaction vessel.

C10

132
199. A cell according to claim 52, wherein said vessel is capable of containing a pressure within the range of 10^{-3} atmospheres to 100 atmospheres.

133
200. A cell according to claim 52, further comprising a vacuum pump in communication with said vessel and said vessel being constructed and arranged to contain pressures less than atmospheric.

134
201. A cell according to claim 78, further comprising a temperature controlling structure capable of maintaining a temperature in the said reaction vessel that is greater than a temperature of said catalyst reservoir.

135
202. A cell according to claim 78, further comprising temperature controlling structure capable of maintaining said source of gaseous catalyst in a molten form.

136
203. A cell according to claim 181, further comprising temperature controlling structure capable of maintaining said source of gaseous catalyst in a molten form.

135

137 27
204. A cell according to claim 78, further comprising temperature controlling structure capable of maintaining the temperature of said catalyst reservoir at about 50°C above the melting point of said gaseous catalyst.

138 1
205. A cell according to claim 52, further comprising temperature controlling structure capable of maintaining the temperature of said reaction vessel at about 50°C above the melting point of a source of gaseous catalyst.

139 114
206. A cell according to claim 181, further comprising temperature controlling structure capable of maintaining the temperature of said boat at about 50°C above the melting point of said gaseous catalyst.

140 15
C10 207. A cell according to claim 66, further comprising a catalyst reservoir in communication with said reaction vessel and temperature controlling structure capable of maintaining the temperature of said catalyst reservoir at about 50°C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise said source of gaseous catalyst.

141 15
208. A cell according to claim 66, further comprising a boat contained in said reaction vessel and temperature controlling structure capable of maintaining the temperature of said boat at about 50°C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise said source of gaseous catalyst.

142 27
209. A cell according to claim 78, further comprising temperature controlling structure capable of maintaining the temperature of said reaction vessel at about 50°C above the melting point of said gaseous catalyst.

136

210. 143 A cell according to claim 66, 15 further comprising a catalyst reservoir containing said source of gaseous catalyst and being in communication with said reaction vessel, and temperature controlling structure capable of maintaining the temperature of said reaction vessel at about 50°C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise said source of gaseous catalyst.

144 211. A cell according to claim 66, 15 further comprising a boat containing said source of gaseous catalyst and being disposed in said reaction vessel, and temperature controlling structure capable of maintaining the temperature of said reaction vessel at about 50°C above the melting point of the compound having the highest melting point of a plurality of compounds which comprise said source of gaseous catalyst.

C10 160 212. A method according to claim 92, 145 further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising an ionic compound which is resistant to hydrogen reduction.

161 213. A method according to claim 92, 145 further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising an ionic compound which is resistant to hydrogen reduction and which is adapted to sublime, boil or become volatile when heated.

162 214. A method according to claim 92, 145 further comprising the step of forming said gaseous compound from a source of gaseous catalyst comprising an ionic compound which is adapted to sublime, boil or become volatile when heated.

163 215. A method according to claim 92, 145 further comprising the step of forming said gaseous compound from a source of gaseous catalyst comprising an ionic compound which is resistant to thermal degradation.

137

164 145
216. A method according to claim 92, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising a salt of rubidium or potassium.

165 145
217. A method according to claim 92, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising a salt that can form a vapor comprising ions when heated.

166 145
218. A method according to claim 92, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising a salt of rubidium selected from the group consisting of RbF, RbCl, RbBr, RbI, Rb_2S_2, RbOH, Rb_2SO_4, Rb_2CO_3, and Rb_3PO_4.

CO

167 145
219. A method according to claim 92, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising a salt of potassium selected from the group consisting of KF, KCl, KBr, KI, K_2S_2, KOH, K_2SO_4, K_2CO_3, K_3PO_4, and K_2GeF_4.

168 145
220. A method according to claim 92, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising at least one metal selected from the group consisting of Mo, Ti, and Rb.

169 145
221. A method according to claim 92, further comprising the step of forming said gaseous hydrogen atoms from a source of gaseous catalyst comprising at least one salt selected from the group consisting of MoI_2, $TiCl_2$, $TiCl_4$, $SnCl_4$, $SiCl_4$, $PrBr_3$, $CaBr_2$, $SrCl_2$, CrI_2, TbI_3, $SbCl_3$, CrF_3, $CoCl_2$, $BiCl_3$, $NiCl_2$, PdF_2, InCl, $LaCl_3$, $DyCl_3$, LaI_3, HoI_3, KNO_3, VF_3, PbF_2, VOCl, PbI_2, $LuCl_3$, $PbCl_2$, AsI_3, HoI_3, $MoCl_5$, $SnCl_4$, SbI_3, CdI_2, AgF_2, AgF, LaI_3, ErI_3, VCl_4, BCl_3, $FeCl_3$, $TiCl_3$, CoI_2, CoF_2, TlI, TlF, $BiBr_3$, $ZnBr_2$,

138

AsI_3, DyI_3, $HoCl_3$, $MgCl_2$, $CrCl_3$, $PrCl_3$, $SrCl_2$, $FeCl_2$, $NiCl_2$, CuCl, $SrCl_2$, $MoCl_2$, YCl_3, $ZrCl_4$, CdI_2, BaI_2, HoI_3, PbI_2, PdF_2, LiF, $EuCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $BiCl_4$, $AlCl_3$, $CaBr_2$, $SmBr_3$, VaF_3, $LaCl_3$, GdI_3, CrI_2, MnI_2, $YbBr_3$, $FeBr_2$, $NiCl_2$, AgCl, $ZnCl_2$, $YbCl_2$, SeF_4, $SnCl_4$, SnF_4, SbI_3, BiI_2, EuF_3, and $PbCl_2$.

190 145

222. A method according to claim ~~92~~, wherein said gaseous catalyst comprises at least one ion selected from the group consisting of Mo^{2+}, Ti^{2+}, and Rb^+.

191 145

223. A method according to claim ~~92~~, wherein said gaseous catalyst comprises at least one pair of ions selected from the group consisting of: (Sn^{4+}, Si^{4+}), (Pr^{3+}, Ca^{2+}), (Sr^{2+}, Cr^{2+}), (Cr^{3+}, Tb^{3+}), (Sb^{3+},Co^{2+}), (Bi^{3+}, Ni^{2+}), (Pd^{2+}, In^+), (La^{3+}, Dy^{3+}), (La^{3+}, Ho^{3+}), (K^+, K^+), (V^{3+}, Pd^{2+}), (Lu^{3+}, Zn^{2+}), (As^{3+}, Ho^{3+}), (Mo^{5+}, Sn^{4+}), (Sb^{3+}, Cd^{2+}), (Ag^{2+},Ag^+), (La^{3+}, Er^{3+}), (V^{4+}, B^{3+}), (Fe^{3+}, Ti^{3+}), (Co^{2+}, Ti^+), (Bi^{3+}, Zn^{2+}), (As^{3+}, Dy^{3+}), (Ho^{3+}, Mg^{2+}), (K^+, Rb^+), (Cr^{3+}, Pr^{3+}), (Sr^{2+}, Fe^{2+}), (Ni^{2+}, Cu^+), (Sr^{2+}, Mo^{2+}), (Y^{3+}, Zr^{4+}), (Cd^{2+}, Ba^{2+}), (Ho^{3+}, Pb^{2+}), (Pb^{2+}, Li^+), (Eu^{3+}, Mg^{2+}), (Er^{3+}, Mg^{2+}), (Bi^{4+}, Al^{3+}), (Ca^{2+}, Sm^{3+}), (V^{3+}, La^{3+}), (Gd^{3+}, Cr^{2+}), (Mn^{2+}, Ti^+), (Yb^{3+}, Fe^{2+}), (Ni^{2+}, Ag^+), (Zn^{2+}, Yb^{2+}), (Se^{4+}, Sn^{4+}), (Sb^{3+}, Bi^{2+}), and (Eu^{3+}, Pb^{2+}).

192 145

224. A method according to claim ~~92~~, further comprising the step of forming said gaseous catalyst from a source of gaseous catalyst comprising a salt of one or more cations and at least one anion selected from the group consisting of halides, sulfates, phosphates, carbonates, hydroxide and sulfides.

193 145

225. A method according to claim ~~92~~, wherein said gaseous catalyst is selected to have a resonant adsorption with the energy released from said gaseous hydrogen atoms undergoing a transition to a lower energy state.

194 145

226. A method according to claim ~~92~~, wherein said gaseous catalyst comprises potassium and has a net enthalpy of reaction of 27.28 eV.

139

175 145
227. A method according to claim 92, wherein said gaseous catalyst has a net enthalpy of reaction of about 27.2 eV.

176 145
228. A method according to claim 92, further comprising the step of combining a source of gaseous catalyst with a source of gaseous hydrogen atoms comprising at least one of a hydrocarbon or water, and providing combustion which volatizes said source of gaseous catalyst to form said gaseous catalyst and provide said gaseous hydrogen atoms.

177 145
229. A method according to claim 92, further comprising the step of forming a source of gaseous catalyst or said gaseous catalyst in situ.

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178 177
230. A method according to claim 229, wherein said step of forming said source of gaseous catalyst or said gaseous catalyst in situ comprises the ionization of a reactant.

179 178
231. A method according to claim 230, wherein said step of ionization comprises thermal ionization of said reactant.

180 178
232. A method according to claim 230, wherein said step of ionization comprises chemical ionization of said reactant.

181 180
233. A method according to claim 232, wherein said step of chemical ionization comprises oxidation or reduction of said reactant.

182 145
234. A method according to claim 92, further comprising the step of volatizing a source of catalyst to form said gaseous catalyst utilizing energy from at least one of heat,

140

electron-beam energy, photon energy, acoustic energy, electric field, or magnetic field.

183 145
235. A method according to claim 92, wherein said the step of volatizing a source of catalyst comprises the step of heating a filament coated with said source of gaseous catalyst.

184 145
236. A method according to claim 92, further comprising adding a source of catalyst to said reaction vessel and heating said source of catalyst to form said gaseous catalyst.

185 145
237. A method according to claim 92, further comprising the step of providing a source of catalyst in a catalyst reservoir comprising a container separate from said vessel and said container communicates with said reaction vessel.

C10

186 145
238. A method according to claim 92, further comprising the step of providing a source of catalyst in a boat contained within said reaction vessel.

187 145
239. A method according to claim 92, wherein said step of providing hydrogen atoms comprises the steps of disassociating a hydrogen containing compound into hydrogen atoms.

188 145
240. A method according to claim 92, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas over a hot filament.

189 145
241. A method according to claim 92, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas over a hot grid.

141

190 145
242. A method according to claim 92, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas through a tungsten capillary heated by electron bombardment.

191 145
243. A method according to claim 92, wherein said step of providing hydrogen atoms comprises the steps of maintaining a hydride under nonequilibrium conditions.

192 147
244. A method according to claim 94, wherein said second catalyst comprises at least one element selected from the group consisting of transition elements, inner transition elements, precious metals, refractory metals, lanthanides, actinides and activated charcoal.

C10 193 147
245. A method according to claim 94, wherein said second catalyst is selected from the group consisting of an element, compound, alloy or mixture of transition elements, inner transition elements, iron, platinum, palladium, zirconium, vanadium, nickel, titanium, Sc, Cr, Mn, Co, Cu, Zn, Y, Nb, Mo, Tc, Ru, Rh, Ag, Cd, La, Hf, Ta, W, Re, Os, Ir, Au, Hg, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Vb, Lu, Th, Pa, U, activated charcoal, and intercalated Cs carbon.

194 147
246. A method according to claim 94, further comprising the step of utilizing a hot filament or hot grid to disassociate a hydrogen containing gas into gaseous hydrogen atoms and to heat said second catalyst.

195 147
247. A method according to claim 94, further comprising the step of controlling the power output of said cell.

196 147
248. A method according to claim 94, wherein said step of controlling the power output of said cell comprises controlling the temperature of said second catalyst.

142

196 197

249. A method according to claim 248, wherein said step of controlling the temperature of said second catalyst comprises utilizing a heated filament or grid.

198 145

250. A method according to claim 92, further comprising the step of forming said gaseous hydrogen atoms from at least one source of gaseous hydrogen atoms selected from the group consisting of hydrogen gas, water, hydrides, metal-hydrogen solutions, and hydrocarbons.

199 145

251. A method according to claim 92, wherein said step of providing gaseous hydrogen atoms comprises pyrolyzing hydrocarbons or water.

C10 200 145

252. A method according to claim 92, further comprising the step of reforming hydrocarbons to at least one of gaseous molecular and gaseous atomic hydrogen.

201 145

253. A method according to claim 92, further comprising the step of disassociating hydrogen containing molecules using UV light to form said gaseous hydrogen atoms.

202 145

254. A method according to claim 92, further comprising the step of controlling the amount of gaseous hydrogen provided in said reaction vessel.

203 145

255. A method according to claim 92, further comprising the step of controlling the flow of a source of gaseous hydrogen atoms or said gaseous hydrogen atoms from a chamber to said reaction vessel.

204 145

256. A method according to claim 92, further comprising the step of utilizing a valve for controlling the flow of gaseous hydrogen or source of gaseous hydrogen from said reaction vessel.

143

205 145
257. A method according to claim 92, further comprising the step of controlling the flow of gaseous hydrogen from said reaction vessel.

206 145
258. A method according to claim 92, further comprising the step of utilizing a vacuum pump for controlling the flow of gaseous hydrogen from said reaction vessel.

207 145
259. A method according to claim 92, further comprising the step of utilizing a valve for controlling the flow of gaseous hydrogen from a chamber into said reaction vessel.

208 145
260. A method according to claim 92, further comprising controlling the partial pressure of said gaseous hydrogen atoms.

C10 209 145
261. A method according to claim 92, wherein a partial pressure of said gaseous hydrogen atoms or source of gaseous hydrogen atoms in said reaction vessel is maintained within the range of 10^{-3} atmospheres to 100 atmospheres.

210 145
262. A method according to claim 92, further comprising controlling the amount of gaseous catalyst or a source of gaseous catalyst introduced into said reaction vessel.

211 145
263. A method according to claim 92, further comprising controlling the flow of gaseous catalyst or a source of gaseous catalyst from a catalyst reservoir containing gaseous catalyst or a source of gaseous catalyst to said reaction vessel.

212 145
264. A method according to claim 92, further comprising controlling the flow of gaseous catalyst or a source of gaseous catalyst from a boat containing gaseous catalyst or a source of gaseous catalyst.

144

213 145
265. A method according to claim ~~92~~, further comprising the step of controlling the flow of said gaseous catalyst or a source of gaseous catalyst from said reaction vessel.

214 145
266. A method according to claim ~~92~~, further comprising the step of controlling the vapor pressure of said gaseous catalyst or a source of gaseous catalyst in said reaction vessel.

215 145
267. A method according to claim ~~92~~, wherein a vapor pressure of said gaseous catalyst or a source of gaseous catalyst is maintained at about 50 to 210 millitorr.

216 145
268. A method according to claim ~~92~~, further comprising using a vacuum pump to control the flow of said gaseous catalyst or a source of gaseous catalyst from said reaction vessel.

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217 145
269. A method according to claim ~~92~~, further comprising using a valve to control the flow of a source of gaseous catalyst or a source of gaseous catalyst from a catalyst reservoir into said reaction vessel.

218 145
270. A method according to claim ~~92~~, further comprising using a valve to control the flow of a source of gaseous catalyst or said catalyst from said reaction vessel.

219 145
271. A method according to claim ~~92~~, further comprising the step of supplying a nonreactive gas to said reaction vessel.

220 219
272. A method according to claim ~~271~~, further comprising the step of controlling the vapor pressure of said nonreactive gas in said reaction vessel.

221 219
273. A method according to claim ~~271~~, further comprising the step of controlling the flow of said nonreactive gas supplied to said reaction vessel.

145

222 219
274. A method according to claim 271, further comprising the step of controlling the amount of said nonreactive gas released from said reaction vessel.

223 219
275. A method according to claim 271, further comprising utilizing a vacuum pump for controlling the flow of said nonreactive gas from said reaction vessel.

224 219
276. A method according to claim 271, further comprising the step of utilizing a valve for controlling the flow of said nonreactive gas from said reaction vessel.

C10 225 219
277. A method according to claim 271, further comprising the step of utilizing a valve for controlling the flow of said nonreactive gas into said reaction vessel.

226 145
278. A method according to claim 92, further comprising the step of controlling the vapor pressure of said gaseous catalyst in said reaction vessel.

227 226
279. A method according to claim 278, wherein said step of controlling the vapor pressure of said gaseous catalyst comprises controlling the temperature in a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel, and controlling the flow of gaseous catalyst from said catalyst reservoir.

228 226
280. A method according to claim 278, wherein said step of controlling the vapor pressure of said gaseous catalyst comprises controlling the temperature in a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel, and controlling the flow of gaseous catalyst from said boat.

146

229 145
281. A method according to claim 92, further comprising the step of controlling the temperature in a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel.

230 145
282. A method according to claim 92, further comprising the step of controlling the temperature in a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel.

231 145
283. A method according to claim 92, wherein the reaction to provide a net enthalpy of about 27 (p/2) eV, where p is a positive integer greater than 1, comprises an electrochemical, chemical, photochemical, thermal, free radical, sonic, nuclear, inelastic photon, or particle scattering reaction, or mixtures thereof.

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232 145
284. A method according to claim 92, wherein a pressure in said reaction vessel is maintained within the range of 10^{-3} atmospheres to 100 atmospheres.

233 145
285. A method according to claim 92, wherein said reaction occurring at a pressure less than atmospheric pressure.

234 145
286. A method according to claim 92, further comprising the step of releasing hydrogen atoms from said reaction vessel having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1 or a compound containing said hydrogen atoms.

235 145
287. A method according to claim 92, further comprising the step of adsorbing said released energy.

236 145
288. A method according to claim 92, further comprising the step of converting energy released from said hydrogen atom into electrical energy.

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237 145
289. A method according to claim 92, wherein said reaction step is conducted in an internal combustion chamber.

238 145
290. A method according to claim 92, wherein said internal combustion chamber is an engine cylinder.

239 145
291. A method according to claim 92, further comprising the step of controlling the power output of said cell.

240 239
292. A method according to claim 291, wherein said step of controlling the power output of said cell comprises controlling the amount of said gaseous catalyst present in said reaction vessel.

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241 240
293. A method according to claim 292, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of said reaction vessel and selecting said gaseous catalyst or source of gaseous catalyst to have a vapor pressure dependent upon the temperature of said reaction vessel.

242 240
294. A method according to claim 292, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel, and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said catalyst reservoir.

243 240
295. A method according to claim 292, wherein said step of controlling the amount of gaseous catalyst comprises controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir into said reaction vessel.

148

296. A method according to claim 292, wherein said step of controlling the amount of gaseous catalyst comprises controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

297. A method according to claim 292, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel, and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said boat.

298. A method according to claim 291, wherein said step of controlling the power output of said cell comprises controlling the amount of said gaseous hydrogen atoms present in said reaction vessel.

299. A method according to claim 298, wherein said step of controlling the amount of said gaseous hydrogen atoms comprises controlling the flow of gaseous hydrogen atoms or source of gaseous hydrogen atoms into said reaction vessel.

300. A method according to claim 298, wherein said step of controlling the amount of said source of gaseous hydrogen atoms or gaseous hydrogen atoms comprises controlling the flow of said source of gaseous hydrogen atoms or gaseous hydrogen atoms from said reaction vessel.

301. A method according to claim 298, wherein said step of controlling the amount of said source of gaseous hydrogen atoms or gaseous hydrogen atoms comprises controlling the temperature of a second catalyst for dissociating a hydrogen containing compound into gaseous hydrogen atoms.

302. A method according to claim 301, wherein said step of controlling the temperature of a second catalyst for dissociating a hydrogen containing compound into gaseous hydrogen atoms comprises controlling the power dissipated in a second catalyst heater.

303. A method according to claim 291, wherein said step of controlling the power output of said cell comprises controlling the amount of nonreactive gas in said reaction vessel.

304. A method according to claim 303, wherein said step of controlling the amount of nonreactive gas in said reaction vessel comprises controlling the flow of nonreactive gas into said reaction vessel.

305. A method according to claim 304, wherein said step of controlling the amount of nonreactive gas in said reaction vessel comprises controlling the flow of nonreactive gas from said reaction vessel.

306. A method according to claim 291, wherein said step of controlling the power output of said cell comprises controlling the temperature of a source of gaseous catalyst.

307. A method according to claim 291, wherein said step of controlling the power output of said cell comprises controlling the flow of a hydrogen containing gas over at least one of a hot filament, a tungsten capillary heated by electron bombardment, or an inductively coupled plasma flow.

308. A method according to claim 291, wherein said step of controlling the power output of said cell comprises controlling the power dissipated in an inductively coupled plasma flow tube, hot filament or grid, or tungsten capillary heated by electron bombardment.

257 239
309. A method according to claim 291, wherein said step of controlling the power output of said cell comprises controlling the temperature of a hot filament or tungsten capillary heated by electron bombardment over which a hydrogen containing gas flows.

258 239
310. A method according to claim 291, wherein said step of controlling the power output of said cell comprises controlling the temperature of a hydride maintained under nonequilibrium conditions.

259 145
311. A method according to claim 92, wherein a temperature in said reaction vessel is maintained at a higher temperature than in a catalyst reservoir in communication with said reaction vessel or a boat contained within said reaction vessel.

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260 145
312. A method according to claim 92, further comprising the step of measuring the temperature of a catalyst reservoir in communication with said reaction vessel or a boat contained in said reaction vessel.

261 145
313. A method according to claim 92, further comprising the step of measuring the temperature of a source of said gaseous catalyst contained in a catalyst reservoir in communication with said reaction vessel or a boat contained within said reaction vessel.

262 145
314. A method according to claim 92, further comprising the step of measuring the temperature of a chamber containing a source of said hydrogen atoms in communication with said reaction vessel.

263 145
315. A method according to claim 92, further comprising the step of measuring the temperature of a source of said gaseous hydrogen atoms.

151

316. A method according to claim 94, further comprising the step of measuring the temperature of said second catalyst.

317. A method according to claim 92, further comprising the step of controlling the temperature of said reaction vessel.

318. A method according to claim 92, further comprising utilizing a nebulizer or atomizer to form said gaseous catalyst.

319. A method according to claim 92, further comprising the step of measuring the pressure in said reaction vessel.

320. A method according to claim 92, further comprising the step of controlling the pressure in said reaction vessel.

321. A method according to claim 92, further comprising the step of measuring the hydrogen pressure in said reaction vessel.

322. A method according to claim 92, further comprising the step of measuring the gaseous catalyst pressure in said reaction vessel.

323. A method according to claim 92, further comprising the step of converting energy released from said gaseous hydrogen atoms into electrical energy.

324. A method according to claim 92, further comprising controlling the pressure of said gaseous catalyst by controlling the amount of said source of catalyst being added to said reaction vessel.

325. A cell for extracting energy from hydrogen atoms comprising:

a reaction vessel;

a source of gaseous hydrogen atoms; and

a source of a gaseous catalyst having a net enthalpy of reaction of about 27(p/2) eV, where p is an integer greater than 1.

326. A cell for extracting energy from hydrogen atoms comprising:

a reaction vessel;

a chamber communicating with said vessel, said chamber containing gaseous hydrogen atoms or a source of said hydrogen atoms; and

a catalyst reservoir communicating with said reaction vessel or a boat contained in said reaction vessel, said catalyst reservoir or boat containing a gaseous catalyst having a net enthalpy of reaction of about 27 * (p/2) eV, where p is an integer greater than 1, or a source of said gaseous catalyst.

327. A cell according to claim 326, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction.

328. A cell according to claim 326, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction and which is adapted to sublime, boil or become volatile when heated.

329. A cell according to claim 326, wherein said source of gaseous catalyst comprises an ionic compound which is adapted to sublime, boil or become volatile when heated.

330. A cell according to claim 326, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to thermal degradation.

331. A cell according to claim 326, wherein said source of gaseous catalyst comprises a salt of rubidium or potassium.

332. A cell according to claim 326, wherein said source of gaseous catalyst comprises a salt that can form a vapor comprising ions when heated.

333. A cell according to claim 326, wherein said source of gaseous catalyst comprises a salt of rubidium selected from the group consisting of RbF, RbCl, RbBr, RbI, Rb_2S_2, RbOH, Rb_2SO_4, Rb_2CO_3, and Rb_3PO_4.

334. A cell according to claim 326, wherein said source of gaseous catalyst comprises a salt of potassium selected from the group consisting of KF, KCl, KBr, KI, K_2S_2, KOH, K_2SO_4, K_2CO_3, K_3PO_4, and K_2GeF_4.

335. A cell according to claim 326, wherein said source of gaseous catalyst comprises at least one metal selected from the group consisting of Mo, Ti, and Rb.

336. A cell according to claim 326, wherein said source of gaseous catalyst comprises at least one salt selected from the group consisting of MoI_2, $TiCl_2$, $TiCl_4$, $SnCl_4$, $SiCl_4$, $PrBr_3$, $CaBr_2$, $SrCl_2$, CrI_2, TbI_3, $SbCl_3$, CrF_3, $CoCl_2$, $BiCl_3$, $NiCl_2$, PdF_2, InCl, $LaCl_3$, $DyCl_3$, LaI_3, HoI_3, KNO_3, VF_3, PbF_2, VOCl, PbI_2, $LuCl_3$, $PbCl_2$, AsI_3, HoI_3, $MoCl_5$, $SnCl_4$, SbI_3, CdI_2, AgF_2, AgF, LaI_3, ErI_3, VCl_4, BCl_3, $FeCl_3$, $TiCl_3$, CoI_2, CoF_2, TlI, TlF, $BiBr_3$, $ZnBr_2$, AsI_3, DyI_3, $HoCl_3$, $MgCl_2$, $CrCl_3$, $PrCl_3$, $SrCl_2$, $FeCl_2$, $NiCl_2$, CuCl, $SrCl_2$, $MoCl_2$, YCl_3, $ZrCl_4$, CdI_2, BaI_2, HoI_3, PbI_2, PdF_2, LiF, $EuCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $BiCl_4$, $AlCl_3$, $CaBr_2$, $SmBr_3$, VaF_3, $LaCl_3$, GdI_3, CrI_2, MnI_2, $YbBr_3$, $FeBr_2$, $NiCl_2$, AgCl, $ZnCl_2$, $YbCl_2$, SeF_4, $SnCl_4$, SnF_4, SbI_3, BiI_2, EuF_3, and $PbCl_2$.

285 274 337. A cell according to claim 326, wherein said gaseous catalyst comprises at least one ion selected from the group consisting of Mo^{2+}, Ti^{2+}, and Rb^{+}.

286 274 338. A cell according to claim 326, wherein said gaseous catalyst comprises at least one pair of ions selected from the group consisting of: (Sn^{4+}, Si^{4+}), (Pr^{3+}, Ca^{2+}), (Sr^{2+}, Cr^{2+}), (Cr^{3+}, Tb^{3+}), (Sb^{3+},Co^{2+}), (Bi^{3+}, Ni^{2+}), (Pd^{2+}, In^{+}), (La^{3+}, Dy^{3+}), (La^{3+}, Ho^{3+}), (K^{+}, K^{+}), (V^{3+}, Pd^{2+}), (Lu^{3+}, Zn^{2+}), (As^{3+}, Ho^{3+}), (Mo^{5+}, Sn^{4+}), (Sb^{3+}, Cd^{2+}), (Ag^{2+},Ag^{+}), (La^{3+}, Er^{3+}), (V^{4+}, B^{3+}), (Fe^{3+}, Ti^{3+}), (Co^{2+}, Ti^{+}), (Bi^{3+}, Zn^{2+}), (As^{3+}, Dy^{3+}), (Ho^{3+}, Mg^{2+}), (K^{+}, Rb^{+}), (Cr^{3+}, Pr^{3+}), (Sr^{2+}, Fe^{2+}), (Ni^{2+}, Cu^{+}), (Sr^{2+}, Mo^{2+}), (Y^{3+}, Zr^{4+}), (Cd^{2+}, Ba^{2+}), (Ho^{3+}, Pb^{2+}), (Pb^{2+}, Li^{+}), (Eu^{3+}, Mg^{2+}), (Er^{3+}, Mg^{2+}), (Bi^{4+}, Al^{3+}), (Ca^{2+}, Sm^{3+}), (V^{3+}, La^{3+}), (Gd^{3+}, Cr^{2+}), (Mn^{2+}, Ti^{+}), (Yb^{3+}, Fe^{2+}), (Ni^{2+}, Ag^{+}), (Zn^{2+}, Yb^{2+}), (Se^{4+}, Sn^{4+}), (Sb^{3+}, Bi^{2+}), and (Eu^{3+}, Pb^{2+}).

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287 274 339. A cell according to claim 326, wherein said source of gaseous catalyst comprises a salt of one or more cations and at least one anion selected from the group consisting of halides, sulfates, phosphates, carbonates, hydroxide and sulfides.

288 274 340. A cell according to claim 326, wherein said gaseous catalyst comprises hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

289 274 341. A cell according to claim 326, wherein said gaseous catalyst comprises potassium and has a net enthalpy of reaction of 27.28 eV.

290 274 342. A cell according to claim 326, wherein said gaseous catalyst has a net enthalpy of reaction of about 27.2 eV.

291 274 343. A cell according to claim 326, wherein said cell comprises said source of said gaseous catalyst combined with at least one of a hydrocarbon or water disposed

155

such that said gaseous catalyst and said gaseous hydrogen atoms are capable being formed during combustion.

292 274
344. A cell according to claim 326, further comprising a means for converting said source of catalyst to said gaseous catalyst.

293 292
345. A cell according to claim 344, wherein said means for converting said source of catalyst to said gaseous catalyst comprises at least one of heat, electron-beam energy, photon energy, acoustic energy, electric field, or magnetic field.

294 274
346. A cell according to claim 326, further comprising a filament coated with said source of gaseous catalyst.

C10

295 274
347. A cell according to claim 326, wherein said source of gaseous hydrogen atoms is selected from the group consisting of hydrogen gas, water, hydrides, metal-hydrogen solutions, and hydrocarbons.

296 274
348. A cell according to claim 326, wherein said source of hydrogen atoms comprises a hot filament and a hydrogen containing gas stream.

297 274
349. A cell according to claim 326, wherein said source of hydrogen atoms comprises a hot grid and a hydrogen containing gas stream.

298 274
350. A cell according to claim 326, wherein said source of hydrogen atoms comprises a heated tungsten capillary and a hydrogen containing gas stream.

299 274
351. A cell according to claim 326, wherein said source of hydrogen atoms comprises a hydride maintained under nonequilibrium conditions.

156

352. A cell according to claim 326, wherein said source of hydrogen atoms comprises an inductively coupled plasma flow tube and a hydrogen gas containing stream.

353. A cell according to claim 326, wherein said source of hydrogen atoms comprises a hydrogen containing gas stream and a second catalyst for disassociating said hydrogen containing gas stream into free hydrogen atoms.

354. A cell according to claim 326, wherein said source of hydrogen atoms comprises an internal combustion engine.

355. A cell according to claim 353, wherein said second catalyst comprises at least one element selected from the group consisting of transition elements, inner transition elements, precious metals, refractory metals, lanthanides, actinides, and activated charcoal.

356. A cell according to claim 353, wherein said second catalyst comprises at least one selected from the group consisting of an element, compound, alloy or mixture of transition elements, inner transition elements, iron, platinum, palladium, zirconium, vanadium, nickel, titanium, Sc, Cr, Mn, Co, Cu, Zn, Y, Nb, Mo, Tc, Ru, Rh, Ag, Cd, La, Hf, Ta, W, Re, Os, Ir, Au, Hg, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Vb, Lu, Th, Pa, U, activated charcoal, and intercalated Cs carbon.

357. A cell according to claim 353, wherein said second catalyst is treated with an aqueous solution of K_2CO_3 and H_2O_2.

358. A cell according to claim 353, further comprising a heater to heat said second catalyst.

359. A cell according to claim 353, further comprising a filament or grid constructed and arranged to dissociate hydrogen and to heat said second catalyst.

360. A cell according to claim 353, further comprising means for controlling the power output of said cell.

361. A cell according to claim 360, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said second catalyst.

362. A cell according to claim 361, wherein said means for controlling the temperature of said second catalyst comprises a filament or grid.

C10

363. A cell according to claim 353, further comprising a temperature controlling structure capable of maintaining a selected atomic hydrogen partial pressure by controlling the temperature of said second catalyst.

364. A cell according to claim 363, wherein said temperature controlling structure is at least one selected from the group consisting of an internal heater, an external heater, the catalysis of hydrogen, and a heat exchanger which removes energy from the cell.

365. A cell according to claim 326, wherein said source of hydrogen atoms comprises a means for pyrolysis of hydrocarbons or water.

366. A cell according to claim 326, further comprising means to reform hydrocarbons to at least one of gaseous molecular and gaseous atomic hydrogen.

158

367. A cell according to claim 326, further comprising a source of UV light for disassociating hydrogen containing molecules to form said gaseous hydrogen atoms.

368. A cell according to claim 326, further comprising a flow control means for controlling the flow of said source of gaseous hydrogen atoms or said gaseous hydrogen atoms from said chamber to said reaction vessel.

369. A cell according to claim 368, wherein said flow control means comprises a valve.

370. A cell according to claim 326, further comprising a flow control means for controlling the flow of hydrogen from said reaction vessel.

371. A cell according to claim 370, wherein said flow control means comprises a valve.

372. A cell according to claim 326, further comprising a vacuum pump constructed and arranged for controlling the flow of hydrogen from said reaction vessel.

373. A cell according to claim 326, further comprising a flow control means for controlling the flow of said gaseous catalyst or a source of gaseous catalyst from said catalyst reservoir to said reaction vessel.

374. A cell according to claim 373, wherein said flow control means comprises a valve.

375. A cell according claim 326, further comprising means for controlling the flow of catalyst from said reaction vessel.

376. A cell according to claim 326, further comprising a valve constructed and arranged for controlling the flow of said catalyst from said reaction vessel.

325 274
377. A cell according to claim 326, further comprising a vacuum pump constructed and arranged for controlling the flow of said gaseous catalyst or source of gaseous catalyst from said reaction vessel.

326 274
378. A cell according to claim 326, further comprising a nonreactive gas.

327 274
379. A cell according to claim 326, further comprising a means for controlling the amount of a nonreactive gas in said vessel.

328 274
380. A cell according to claim 326, further comprising flow control means for controlling the flow of a nonreactive gas into said reaction vessel.

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329 328
381. A cell according to claim 380, wherein said means for controlling the amount of nonreactive gas in said vessel comprises a valve constructed and arranged to regulate the release of said nonreactive gas from said reaction vessel.

330 274
382. A cell according to claim 326, further comprising a valve constructed and arranged for controlling the flow of a nonreactive gas from said reaction vessel.

331 274
383. A cell according to claim 326, further comprising a vacuum pump constructed and arranged for controlling the flow of a nonreactive gas from said reaction vessel.

332 274
384. A cell according to claim 326, further comprising a pump in communication with said reaction vessel.

333 274
385. A cell according to claim 326, further comprising structure for controlling the vapor pressure of said catalyst.

160

386. A cell according to claim 385, wherein said structure for controlling the vapor pressure of said catalyst comprises a heater constructed and arranged to control the temperature of said catalyst reservoir or said boat.

387. A cell according to claim 385, wherein said structure for controlling the vapor pressure of said catalyst comprises a heater constructed and arranged to control the temperature of said reaction chamber.

388. A cell according to claim 326, further comprising structure for maintaining a selected vapor pressure of said gaseous catalyst.

389. A cell according to claim 388, wherein said structure for maintaining a selected vapor pressure of said gaseous catalyst comprises a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir and a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

390. A cell according to claim 388, wherein said structure for maintaining a selected vapor pressure of said source of gaseous catalyst or said gaseous catalyst comprises a valve constructed and arranged for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

391. A cell according to claim 326, further comprising a valve for releasing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1 or a compound containing said hydrogen atoms.

392. A cell according to claim 326, further comprising means for adsorbing energy released from said hydrogen atom.

393. A cell according to claim 326, wherein said vessel comprises an internal combustion chamber.

394. A cell according to claim 393, wherein said internal combustion chamber is an engine cylinder.

395. A cell according to claim 326, further comprising means for controlling the power output of said cell.

396. A cell according to claim 395, wherein said means for controlling the power output of said cell comprises means for controlling the amount of said gaseous catalyst.

397. A cell according to claim 396, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the temperature of said vessel and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said reaction vessel.

398. A cell according to claim 396, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the temperature of said catalyst reservoir and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said catalyst reservoir.

399. A cell according to claim 396, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the temperature of said boat and said gaseous catalyst is selected to have a vapor pressure dependent upon the temperature of said boat.

348 344

400. A cell according to claim 396, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir into said reaction vessel.

349 344

401. A cell according to claim 396, wherein said means for controlling the amount of gaseous catalyst comprises means for controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir from said reaction vessel.

350 343

402. A cell according to claim 395, wherein said means for controlling the power output of said cell comprises means for controlling the amount of said gaseous hydrogen atoms or said source of gaseous hydrogen atoms in said vessel.

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351 350

403. A cell according to claim 402, wherein said means for controlling the amount of said gaseous hydrogen atoms or said source of gaseous hydrogen atoms comprises means for controlling the flow of gaseous hydrogen atoms or source of said hydrogen atoms into said vessel.

352 350

404. A cell according to claim 402, wherein said means for controlling the amount of said gaseous hydrogen atoms or said source of gaseous hydrogen atoms comprises means for controlling the flow of gaseous hydrogen atoms or source of said hydrogen atoms from said vessel.

353 343

405. A cell according to claim 395, wherein said means for controlling the power output of said cell comprises controlling the amount of said nonreactive gas present in said reaction vessel.

163

406. A cell according to claim 405, wherein said means for controlling the amount of nonreactive gas comprises means for controlling the flow of said nonreactive gas into said reaction vessel.

407. A cell according to claim 406, wherein said means for controlling the amount of nonreactive gas comprises means for controlling the flow of said nonreactive gas from said reaction vessel.

408. A cell according to claim 395, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of said source of catalyst.

409. A cell according to claim 395, wherein said means for controlling the power output of said cell comprises means for controlling the flow of a hydrogen containing gas over at least one of a hot filament, a tungsten capillary heated by electron bombardment, or an inductively coupled plasma flow.

410. A cell according to claim 395, wherein said means for controlling the power output of said cell comprises means for controlling the power dissipated in an inductively coupled plasma flow tube.

411. A cell according to claim 395, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a hot filament or tungsten capillary heated by electron bombardment over which a hydrogen containing gas flows.

412. A cell according to claim 395, wherein said means for controlling the power output of said cell comprises means for controlling the temperature of a hydride maintained under nonequilibrium conditions.

361 274
413. A cell according to claim 326, further comprising means for measuring the temperature of said catalyst reservoir or said boat.

362 274
414. A cell according to claim 326, further comprising a means for measuring the temperature of said source of said gaseous catalyst contained in said catalyst reservoir or said boat.

363 274
415. A cell according to claim 326, further comprising means for measuring the temperature of said reaction vessel.

C10 364 274
416. A cell according to claim 326, further comprising means for measuring the temperature of said source of said gaseous hydrogen atoms.

365 301
417. A cell according to claim 353, further comprising means for measuring the temperature said second catalyst.

366 274
418. A cell according to claim 326, further comprising means to measure the cell temperature.

367 274
419. A cell according to claim 326, further comprising temperature controlling structure constructed and arranged to maintain a temperature in said reaction vessel greater than a temperature in said catalyst reservoir.

368 274
420. A cell according to claim 326, further comprising temperature controlling structure constructed and arranged to maintain a temperature in said reaction vessel greater than a temperature in said boat.

165

369 374
421. A cell according to claim 326, further comprising temperature controlling structure for maintaining a selected temperature of said reaction vessel.

370 374
422. A cell according to claim 326, further comprising a nebulizer or atomizer.

371 374
423. A cell according to claim 326, further comprising means to measure the pressure in said reaction vessel.

372 374
424. A cell according to claim 326, further comprising means to measure the hydrogen pressure in said reaction vessel.

C10 373 374
425. A cell according to claim 326, further comprising means to measure the gaseous catalyst pressure in said reaction vessel.

374 374
426. A cell according to claim 326, wherein said vessel is capable of containing a pressure within the range of 10^{-3} atmospheres to 100 atmospheres.

375
427. A method for extracting energy from hydrogen atoms comprising the steps of:

volatizing a source of gaseous catalyst to form a gaseous catalyst having a net enthalpy of reaction of about 27 * (p/2) eV, where p is an integer greater than 1;

providing gaseous hydrogen atoms; and

reacting said gaseous catalyst with said gaseous hydrogen atoms, thereby releasing energy from said gaseous hydrogen atoms and producing hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and a denominator is an integer greater than 1.

376 375
428. A method according to claim 427, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction.

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377 375

429. A method according to claim 427, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to hydrogen reduction and which is adapted to sublime, boil or become volatile when heated.

378 375

430. A method according to claim 427, wherein said source of gaseous catalyst comprises an ionic compound which is adapted to sublime, boil or become volatile when heated.

379 375

431. A method according to claim 427, wherein said source of gaseous catalyst comprises an ionic compound which is resistant to thermal degradation.

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380 375

432. A method according to claim 427, wherein said source of gaseous catalyst comprises a salt of rubidium or potassium.

381 375

433. A method according to claim 427, wherein said source of gaseous catalyst comprises a salt that can form a vapor comprising ions when heated.

382 375

434. A method according to claim 427, wherein said source of gaseous catalyst comprises a salt of rubidium selected from the group consisting of RbF, RbCl, RbBr, RbI, Rb_2S_2, RbOH, Rb_2SO_4, Rb_2CO_3, and Rb_3PO_4.

383 375

435. A method according to claim 427, wherein said source of gaseous catalyst comprises a salt of potassium selected from the group consisting of KF, KCl, KBr, KI, K_2S_2, KOH, K_2SO_4, K_2CO_3, K_3PO_4, and K_2GeF_4.

384 375

436. A method according to claim 427, wherein said source of gaseous catalyst comprises at least one metal selected from the group consisting of Mo, Ti, and Rb.

167

437. A method according to claim 427, wherein said source of gaseous catalyst comprises at least one salt selected from the group consisting of MoI_2, $TiCl_2$, $TiCl_4$, $SnCl_4$, $SiCl_4$, $PrBr_3$, $CaBr_2$, $SrCl_2$, CrI_2, TbI_3, $SbCl_3$, CrF_3, $CoCl_2$, $BiCl_3$, $NiCl_2$, PdF_2, InCl, $LaCl_3$, $DyCl_3$, LaI_3, HoI_3, KNO_3, VF_3, PbF_2, VOCl, PbI_2, $LuCl_3$, $PbCl_2$, AsI_3, HoI_3, $MoCl_5$, $SnCl_4$, SbI_3, CdI_2, AgF_2, AgF, LaI_3, ErI_3, VCl_4, BCl_3, $FeCl_3$, $TiCl_3$, CoI_2, CoF_2, TlI, TlF, $BiBr_3$, $ZnBr_2$, AsI_3, DyI_3, $HoCl_3$, $MgCl_2$, $CrCl_3$, $PrCl_3$, $SrCl_2$, $FeCl_2$, $NiCl_2$, CuCl, $SrCl_2$, $MoCl_2$, YCl_3, $ZrCl_4$, CdI_2, BaI_2, HoI_3, PbI_2, PdF_2, LiF, $EuCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $BiCl_4$, $AlCl_3$, $CaBr_2$, $SmBr_3$, VaF_3, $LaCl_3$, GdI_3, CrI_2, MnI_2, $YbBr_3$, $FeBr_2$, $NiCl_2$, AgCl, $ZnCl_2$, $YbCl_2$, SeF_4, $SnCl_4$, SnF_4, SbI_3, BiI_2, EuF_3, and $PbCl_2$.

438. A method according to claim 427, wherein said gaseous catalyst comprises at least one ion selected from the group consisting of Mo^{2+}, Ti^{2+}, and Rb^{+}.

439. A method according to claim 427, wherein said gaseous catalyst comprises at least one pair of ions selected from the group consisting of: (Sn^{4+}, Si^{4+}), (Pr^{3+}, Ca^{2+}), (Sr^{2+}, Cr^{2+}), (Cr^{3+}, Tb^{3+}), (Sb^{3+},Co^{2+}), (Bi^{3+}, Ni^{2+}), (Pd^{2+}, In^{+}), (La^{3+}, Dy^{3+}), (La^{3+}, Ho^{3+}), (K^{+}, K^{+}), (V^{3+}, Pd^{2+}), (Lu^{3+}, Zn^{2+}), (As^{3+}, Ho^{3+}), (Mo^{5+}, Sn^{4+}), (Sb^{3+}, Cd^{2+}), (Ag^{2+},Ag^{+}), (La^{3+}, Er^{3+}), (V^{4+}, B^{3+}), (Fe^{3+}, Ti^{3+}), (Co^{2+}, Ti^{+}), (Bi^{3+}, Zn^{2+}), (As^{3+}, Dy^{3+}), (Ho^{3+}, Mg^{2+}), (K^{+}, Rb^{+}), (Cr^{3+}, Pr^{3+}), (Sr^{2+}, Fe^{2+}), (Ni^{2+}, Cu^{+}), (Sr^{2+}, Mo^{2+}), (Y^{3+}, Zr^{4+}), (Cd^{2+}, Ba^{2+}), (Ho^{3+}, Pb^{2+}), (Pb^{2+}, Li^{+}), (Eu^{3+}, Mg^{2+}), (Er^{3+}, Mg^{2+}), (Bi^{4+}, Al^{3+}), (Ca^{2+}, Sm^{3+}), (V^{3+}, La^{3+}), (Gd^{3+}, Cr^{2+}), (Mn^{2+}, Ti^{+}), (Yb^{3+}, Fe^{2+}), (Ni^{2+}, Ag^{+}), (Zn^{2+}, Yb^{2+}), (Se^{4+}, Sn^{4+}), (Sb^{3+}, Bi^{2+}), and (Eu^{3+}, Pb^{2+}).

440. A method according to claim 427, wherein said source of gaseous catalyst comprises a salt of one or more cations and at least one anion selected from the group consisting of halides, sulfates, phosphates, carbonates, hydroxide and sulfides.

441. A method according to claim 427, wherein said gaseous catalyst comprises hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

442. A method according to claim 427, wherein said catalyst is selected to have a resonant adsorption with the energy released from said gaseous hydrogen atoms undergoing a transition to a lower energy state.

443. A method according to claim 427, wherein said gaseous catalyst comprises potassium and has a net enthalpy of reaction of 27.28 eV.

444. A method according to claim 427, wherein said gaseous catalyst has a net enthalpy of reaction of about 27.2 eV.

445. A method according to claim 427, further comprising the step of combining a source of gaseous catalyst with a source of gaseous hydrogen atoms comprising at least one of a hydrocarbon or water, and providing combustion which volatizes said source of gaseous catalyst to form said gaseous catalyst and provide said gaseous hydrogen atoms.

446. A method according to claim 427, further comprising the step of forming said source of gaseous catalyst or said gaseous catalyst in situ.

447. A method according to claim 446, wherein said step of forming said source of gaseous catalyst or said gaseous catalyst in situ comprises the ionization of a reactant.

448. A method according to claim 447, wherein said step of ionization comprises thermal ionization of said reactant.

449. A method according to claim 447, wherein said step of ionization comprises chemical ionization of said reactant.

450. A method according to claim 449, wherein said step of chemical ionization comprises oxidation or reduction of said reactant.

451. A method according to claim 427, wherein said step of volatizing said source of catalyst to form said gaseous catalyst utilizes energy from at least one of heat, electron-beam energy, photon energy, acoustic energy, electric field, or magnetic field.

452. A method according to claim 427, wherein said step of volatizing said source of catalyst comprises the step of heating a filament coated with said source of said gaseous catalyst.

453. A method according to claim 427, wherein said step of volatizing said source of gaseous catalyst to form said gaseous catalyst comprises the steps of volatizing said material to form gaseous atoms and ionizing said gaseous atoms to form ions.

454. A method according to claim 427, further comprising adding a source of catalyst to said reaction vessel and heating said source of catalyst to form said gaseous catalyst.

455. A method according to claim 427, wherein said source of catalyst is provided in a catalyst reservoir comprising a container separate from said reaction vessel and said container communicates with said reaction vessel.

456. A method according to claim 427, wherein said source of catalyst is provided in a boat contained within said reaction vessel.

457. A method according to claim 427, wherein said step of providing hydrogen atoms comprises the steps of disassociating a hydrogen containing compound into hydrogen atoms.

458. A method according to claim 427, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas over a hot filament.

459. A method according to claim 427, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas over a hot grid.

460. A method according to claim 427, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas through a tungsten capillary heated by electron bombardment.

461. A method according to claim 427, wherein said step of providing hydrogen atoms comprises the steps of maintaining a hydride under nonequilibrium conditions.

462. A method according to claim 427, wherein said step of providing hydrogen atoms comprises the steps of passing a hydrogen containing gas through an inductively coupled plasma flow tube.

463. A method according to claim 427, wherein said step of providing hydrogen atoms comprises the steps of contacting a hydrogen containing gas with a second catalyst for disassociating said hydrogen containing gas into free hydrogen atoms.

464. A method according to claim 463, wherein said second catalyst comprises at least one element selected from the group consisting of transition elements, inner transition elements, precious metals, refractory metals, lanthanides, actinides and activated charcoal.

465. A method according to claim 463, wherein said second catalyst is selected from the group consisting of an element, compound, alloy or mixture of transition elements, inner transition elements, iron, platinum, palladium, zirconium, vanadium, nickel, titanium, Sc, Cr, Mn, Co, Cu, Zn, Y, Nb, Mo, Tc, Ru, Rh, Ag, Cd, La, Hf, Ta, W, Re, Os, Ir, Au, Hg, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Vb, Lu, Th, Pa, U, activated charcoal, and intercalated Cs carbon.

466. A method according to claim 463, further comprising the step of utilizing a hot filament or hot grid to disassociate a hydrogen containing gas into gaseous hydrogen atoms and to heat said second catalyst.

467. A method according to claim 463, further comprising the step of controlling the power output of said cell.

468. A method according to claim 467, wherein said step of controlling the power output of said cell comprises controlling the temperature of said second catalyst.

469. A method according to claim 468, wherein said step of controlling the temperature of said second catalyst comprises utilizing a heated filament or grid.

470. A method according to claim 427, wherein said source of gaseous hydrogen atoms is selected from the group consisting of hydrogen gas, water, hydrides, metal-hydrogen solutions, and hydrocarbons.

419 375
471. A method according to claim 427, wherein said step of providing gaseous hydrogen atoms comprises pyrolyzing hydrocarbons or water.

420 375
472. A method according to claim 427, further comprising the step of reforming hydrocarbons to at least one of gaseous molecular and gaseous atomic hydrogen.

421 375
473. A method according to claim 427, further comprising the step of disassociating hydrogen containing molecules using UV light to form said gaseous hydrogen atoms.

C10 422 375
474. A method according to claim 427, further comprising the step of controlling the amount of gaseous hydrogen provided in said reaction vessel.

423 375
475. A method according to claim 427, further comprising the step of controlling the flow of a source of gaseous hydrogen atoms or said gaseous hydrogen atoms from a chamber to said reaction vessel.

424 375
476. A method according to claim 427, further comprising the step of utilizing a valve for controlling the flow of gaseous hydrogen or source of gaseous hydrogen from said reaction vessel.

425 375
477. A method according to claim 427, further comprising the step of controlling the flow of gaseous hydrogen or source of gaseous hydrogen from said reaction vessel.

426 375
478. A method according to claim 427, further comprising the step of utilizing a vacuum pump for controlling the flow of gaseous hydrogen or source of gaseous hydrogen from said reaction vessel.

427 375
479. A method according to claim 427, further comprising the step of utilizing a valve for controlling the flow of gaseous hydrogen or source of gaseous hydrogen from a chamber into said reaction vessel.

428 375
480. A method according to claim 427, further comprising controlling the partial pressure of said gaseous hydrogen atoms.

429 375
481. A method according to claim 427, wherein a partial pressure of said gaseous hydrogen atoms or source of gaseous hydrogen atoms in said reaction vessel is maintained within the range of 10^{-3} atmospheres to 100 atmospheres.

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430 375
482. A method according to claim 427, further comprising controlling the amount of gaseous catalyst or source of gaseous catalyst introduced into said reaction vessel.

431 375
483. A method according to claim 427, further comprising controlling the flow of gaseous catalyst or source of gaseous catalyst from a catalyst reservoir containing gaseous catalyst or a source of gaseous catalyst to said reaction vessel.

432 375
484. A method according to claim 427, further comprising controlling the flow of gaseous catalyst or source of gaseous catalyst from a boat containing gaseous catalyst or a source of gaseous catalyst.

433 375
485. A method according to claim 427, further comprising the step of controlling the flow of said gaseous catalyst or said source of gaseous catalyst from said reaction vessel.

434 375
486. A method according to claim 427, further comprising the step of controlling the vapor pressure of said gaseous catalyst or source of gaseous catalyst in said reaction vessel.

174

435 375
487. A method according to claim 427, wherein a vapor pressure of said gaseous catalyst or said source of gaseous catalyst is maintained at about 50 to 210 millitorr.

436 375
488. A method according to claim 427, further comprising using a vacuum pump to control the flow of said catalyst or said source of gaseous catalyst from said reaction vessel.

437 375
489. A method according to claim 427, further comprising using a valve to control the flow of said source of gaseous catalyst or said catalyst from a catalyst reservoir into said reaction vessel.

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438 375
490. A method according to claim 427, further comprising using a valve to control the flow of said source of gaseous catalyst or said catalyst from said reaction vessel.

439 375
491. A method according to claim 427, further comprising the step of supplying a nonreactive gas to said reaction vessel.

440 375
492. A method according to claim 427, further comprising the step of controlling the vapor pressure of said nonreactive gas in said reaction vessel.

441 440
493. A method according to claim 492, further comprising the step of controlling the flow of said nonreactive gas supplied to said reaction vessel.

442 440
494. A method according to claim 492, further comprising the step of controlling the amount of said nonreactive gas released from said reaction vessel.

443 440
495. A method according to claim 492, further comprising utilizing a vacuum pump for controlling the flow of said nonreactive gas from said reaction vessel.

175

444 440
496. A method according to claim 492, further comprising the step of utilizing a valve for controlling the flow of said nonreactive gas from said reaction vessel.

445 440
497. A method according to claim 492, further comprising the step of utilizing a valve for controlling the flow of said nonreactive gas into said reaction vessel.

446 375
498. A method according to claim 427, further comprising the step of controlling the vapor pressure of said gaseous catalyst in said reaction vessel.

C10 447 446
499. A method according to claim 498, wherein said step of controlling the vapor pressure of said gaseous catalyst comprises controlling the temperature in a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel, and controlling the flow of gaseous catalyst from said catalyst reservoir.

448 446
500. A method according to claim 498, wherein said step of controlling the vapor pressure of said gaseous catalyst comprises controlling the temperature in a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel, and controlling the flow of gaseous catalyst from said boat.

449 375
501. A method according to claim 427, further comprising the step of controlling the temperature in a catalyst reservoir containing a source of gaseous catalyst or said gaseous catalyst and being in communication with said reaction vessel.

450 375
502. A method according to claim 427, further comprising the step of controlling the temperature in a boat containing a source of gaseous catalyst or said gaseous catalyst and being contained in said reaction vessel.

451 375
503. A method according to claim 427, wherein the reaction to provide a net enthalpy of about 27 (p/2) eV, where p is a positive integer greater than 1, comprises an electrochemical, chemical, photochemical, thermal, free radical, sonic, nuclear, inelastic photon, or particle scattering reaction, or mixtures thereof.

452 375
504. A method according to claim 427, wherein a pressure in said reaction vessel is maintained within the range of 10^{-3} atmospheres to 100 atmospheres.

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453 375
505. A method according to claim 427, wherein said reaction occurring at a pressure less than atmospheric pressure.

454 375
506. A method according to claim 427, further comprising the step of releasing hydrogen atoms from said reaction vessel having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1 or a compound containing said hydrogen atoms.

455 375
507. A method according to claim 427, further comprising the step of adsorbing said released energy.

456 375
508. A method according to claim 427, further comprising the step of converting energy released from said hydrogen atom into electrical energy.

457 375
509. A method according to claim 427, wherein said reaction step is conducted in an internal combustion chamber.

458 457
510. A method according to claim 509, wherein said internal combustion chamber is an engine cylinder.

177

459 375
511. A method according to claim 427, further comprising the step of controlling the power output of said cell.

460 459
512. A method according to claim 511, wherein said step of controlling the power output of said cell comprises controlling the amount of said gaseous catalyst present in said reaction vessel.

461 460
513. A method according to claim 512, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of said reaction vessel and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said reaction vessel.

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462 460
514. A method according to claim 512, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of a catalyst reservoir containing a source of gaseous catalyst or said gaseous and being in communication with said reaction vessel, and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said catalyst reservoir.

463 460
515. A method according to claim 512, wherein said step of controlling the amount of gaseous catalyst comprises controlling the flow of said source of gaseous catalyst or gaseous catalyst from said catalyst reservoir into said reaction vessel.

464 460
516. A method according to claim 512, wherein said step of controlling the amount of gaseous catalyst comprises controlling the flow of said source of gaseous catalyst or gaseous catalyst from said reaction vessel.

465 460
517. A method according to claim 512, wherein said step of controlling the amount of gaseous catalyst comprises controlling the temperature of a boat containing a source of gaseous catalyst or said gaseous and being contained in said reaction

178

vessel, and selecting said gaseous catalyst to have a vapor pressure dependent upon the temperature of said boat.

466 459
518. A method according to claim 511, wherein said step of controlling the power output of said cell comprises controlling the amount of said gaseous hydrogen atoms or source of gaseous hydrogen atoms present in said reaction vessel.

467 466
519. A method according to claim 518, wherein said step of controlling the amount of said gaseous hydrogen atoms or source of gaseous hydrogen atoms comprises controlling the flow of gaseous hydrogen atoms or source of gaseous hydrogen atoms into said reaction vessel.

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468 466
520. A method according to claim 518, wherein said step of controlling the amount of said source of gaseous hydrogen atoms or gaseous hydrogen atoms comprises controlling the flow of said source of gaseous hydrogen atoms or gaseous hydrogen atoms from said reaction vessel.

469 466
521. A method according to claim 518, wherein said step of controlling the amount of said source of gaseous hydrogen atoms or gaseous hydrogen atoms comprises controlling the temperature of a second catalyst for dissociating a hydrogen containing compound into gaseous hydrogen atoms.

470 469
522. A method according to claim 521, wherein said step of controlling the temperature of a second catalyst for dissociating a hydrogen containing compound into gaseous hydrogen atoms comprises controlling the power dissipated in a second catalyst heater.

523. A method according to claim 511, wherein said step of controlling the power output of said cell comprises controlling the amount of nonreactive gas in said reaction vessel.

524. A method according to claim 523, wherein said step of controlling the amount of nonreactive gas in said reaction vessel comprises controlling the flow of nonreactive gas into said reaction vessel.

525. A method according to claim 524, wherein said step of controlling the amount of nonreactive gas in said reaction vessel comprises controlling the flow of nonreactive gas from said reaction vessel.

526. A method according to claim 511, wherein said step of controlling the power output of said cell comprises controlling the temperature of a source of gaseous catalyst.

527. A method according to claim 511, wherein said step of controlling the power output of said cell comprises controlling the flow of a hydrogen containing gas over at least one of a hot filament, a tungsten capillary heated by electron bombardment, or an inductively coupled plasma flow.

528. A method according to claim 511, wherein said step of controlling the power output of said cell comprises controlling the power dissipated in an inductively coupled plasma flow tube, hot filament or grid, or tungsten capillary heated by electron bombardment.

529. A method according to claim 511, wherein said step of controlling the power output of said cell comprises controlling the temperature of a hot filament or tungsten capillary heated by electron bombardment over which a hydrogen containing gas flows.

478 459
530. A method according to claim 511, wherein said step of controlling the power output of said cell comprises controlling the temperature of a hydride maintained under nonequilibrium conditions.

479 375
531. A method according to claim 427, wherein a temperature in said reaction vessel is maintained at a higher temperature than in a catalyst reservoir in communication with said reaction vessel or a boat contained within said reaction vessel.

480 375
532. A method according to claim 427, further comprising the step of measuring the temperature of a catalyst reservoir in communication with said reaction vessel or a boat contained in said reaction vessel.

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481 375
533. A method according to claim 427, further comprising the step of measuring the temperature of a source of said gaseous catalyst contained in a catalyst reservoir in communication with said reaction vessel or a boat contained within said reservoir.

482 375
534. A method according to claim 427, further comprising the step of measuring the temperature of a chamber containing a source of said hydrogen atoms in communication with said reaction vessel.

483 375
535. A method according to claim 427, further comprising the step of measuring the temperature of a source of said gaseous hydrogen atoms.

484 411
536. A method according to claim 463, further comprising the step of measuring the temperature of said second catalyst.

485 375
537. A method according to claim 427, further comprising the step of controlling the temperature of said reaction vessel.

181

486 375
538. A method according to claim 427, further comprising utilizing a nebulizer or atomizer to form said gaseous catalyst.

487 375
539. A method according to claim 427, further comprising the step of measuring the pressure in said reaction vessel.

488 375
540. A method according to claim 427, further comprising the step of controlling the pressure in said reaction vessel.

489 375
541. A method according to claim 427, further comprising the step of measuring the hydrogen pressure in said reaction vessel.

490 375
542. A method according to claim 427, further comprising the step of measuring the gaseous catalyst pressure in said reaction vessel.

491 375
543. A method according to claim 427, further comprising the step of converting energy released from said gaseous hydrogen atoms into electrical energy.

492 375
544. A method according to claim 427, further comprising controlling the pressure of said gaseous catalyst by controlling the amount of said source of catalyst being added to said reaction vessel.

493
545. A cell comprising:

a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;

a source of hydrogen atoms; and

182

a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen.

494
546. A cell comprising:

a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;

a source of hydrogen atoms; and

a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said gaseous catalyst comprises hydrogen atoms having a binding energy of about $E_b = 13.6/n^2$ eV, where n is a fraction whose numerator is 1 and denominator is an integer greater than 1.

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495
547. A cell comprising:

a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;

a source of hydrogen atoms; and

a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said source of gaseous catalyst comprises at least one salt selected from the group consisting of RbF, RbCl, RbBr, RbI, Rb_2S_2, RbOH, Rb_2SO_4, Rb_2CO_3, Rb_3PO_4, KF, KCl, KBr, KI, K_2S_2, KOH, K_2SO_4, K_2CO_3, K_3PO_4, and K_2GeF_4.

496
548. A cell comprising:

183

a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;

a source of hydrogen atoms; and

a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said gaseous catalyst comprises at least one ion selected from the group consisting of Mo^{2+}, Ti^{2+}, and Rb^{+}.

U97

549. A cell comprising:

a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;

a source of hydrogen atoms; and

a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said source of gaseous catalyst comprises at least one metal selected from the group consisting of Mo, Ti, and Rb.

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U98

550. A cell comprising:

a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;

a source of hydrogen atoms; and

a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said source of gaseous catalyst comprises at least one salt selected from the group consisting of MoI_2, $TiCl_2$, $TiCl_4$, $SnCl_4$, $SiCl_4$, $PrBr_3$, $CaBr_2$, $SrCl_2$, CrI_2, TbI_3, $SbCl_3$, CrF_3, $CoCl_2$, $BiCl_3$, $NiCl_2$, PdF_2,

184

InCl, $LaCl_3$, $DyCl_3$, LaI_3, HoI_3, KNO_3, VF_3, PbF_2, VOCl, PbI_2, $LuCl_3$, $PbCl_2$, AsI_3, HoI_3, $MoCl_5$, $SnCl_4$, SbI_3, CdI_2, AgF_2, AgF, LaI_3, ErI_3, VCl_4, BCl_3, $FeCl_3$, $TiCl_3$, CoI_2, CoF_2, TlI, TlF, $BiBr_3$, $ZnBr_2$, AsI_3, DyI_3, $HoCl_3$, $MgCl_2$, $CrCl_3$, $PrCl_3$, $SrCl_2$, $FeCl_2$, $NiCl_2$, CuCl, $SrCl_2$, $MoCl_2$, YCl_3, $ZrCl_4$, CdI_2, BaI_2, HoI_3, PbI_2, PdF_2, LiF, $EuCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $ErCl_3$, $MgCl_2$, $BiCl_4$, $AlCl_3$, $CaBr_2$, $SmBr_3$, VaF_3, $LaCl_3$, GdI_3, CrI_2, MnI_2, $YbBr_3$, $FeBr_2$, $NiCl_2$, AgCl, $ZnCl_2$, $YbCl_2$, SeF_4, $SnCl_4$, SnF_4, SbI_3, BiI_2, EuF_3, and $PbCl_2$.

499

551. A cell comprising:

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a reaction vessel capable of containing a vacuum or pressures greater than atmospheric;

a source of hydrogen atoms; and

a source of a gaseous catalyst or a gaseous catalyst capable of accepting energy from atomic hydrogen thereby catalyzing a transition of the electron of atomic hydrogen to a state lower than that of uncatalyzed hydrogen and releasing energy from said hydrogen atom, wherein said gaseous catalyst comprises at least one pair of ions selected from the group consisting of: (Sn^{4+}, Si^{4+}), (Pr^{3+}, Ca^{2+}), (Sr^{2+}, Cr^{2+}), (Cr^{3+}, Tb^{3+}), (Sb^{3+},Co^{2+}), (Bi^{3+}, Ni^{2+}), (Pd^{2+}, In^{+}), (La^{3+}, Dy^{3+}), (La^{3+}, Ho^{3+}), (K^{+}, K^{+}), (V^{3+}, Pd^{2+}), (Lu^{3+}, Zn^{2+}), (As^{3+}, Ho^{3+}), (Mo^{5+}, Sn^{4+}), (Sb^{3+}, Cd^{2+}), (Ag^{2+},Ag^{+}), (La^{3+}, Er^{3+}), (V^{4+}, B^{3+}), (Fe^{3+}, Ti^{3+}), (Co^{2+}, Ti^{+}), (Bi^{3+}, Zn^{2+}), (As^{3+}, Dy^{3+}), (Ho^{3+}, Mg^{2+}), (K^{+}, Rb^{+}), (Cr^{3+}, Pr^{3+}), (Sr^{2+}, Fe^{2+}), (Ni^{2+}, Cu^{+}), (Sr^{2+}, Mo^{2+}), (Y^{3+}, Zr^{4+}), (Cd^{2+}, Ba^{2+}), (Ho^{3+}, Pb^{2+}), (Pb^{2+}, Li^{+}), (Eu^{3+}, Mg^{2+}), (Er^{3+}, Mg^{2+}), (Bi^{4+}, Al^{3+}), (Ca^{2+}, Sm^{3+}), (V^{3+}, La^{3+}), (Gd^{3+}, Cr^{2+}), (Mn^{2+}, Ti^{+}), (Yb^{3+}, Fe^{2+}), (Ni^{2+}, Ag^{+}), (Zn^{2+}, Yb^{2+}), (Se^{4+}, Sn^{4+}), (Sb^{3+}, Bi^{2+}), and (Eu^{3+}, Pb^{2+}).

185